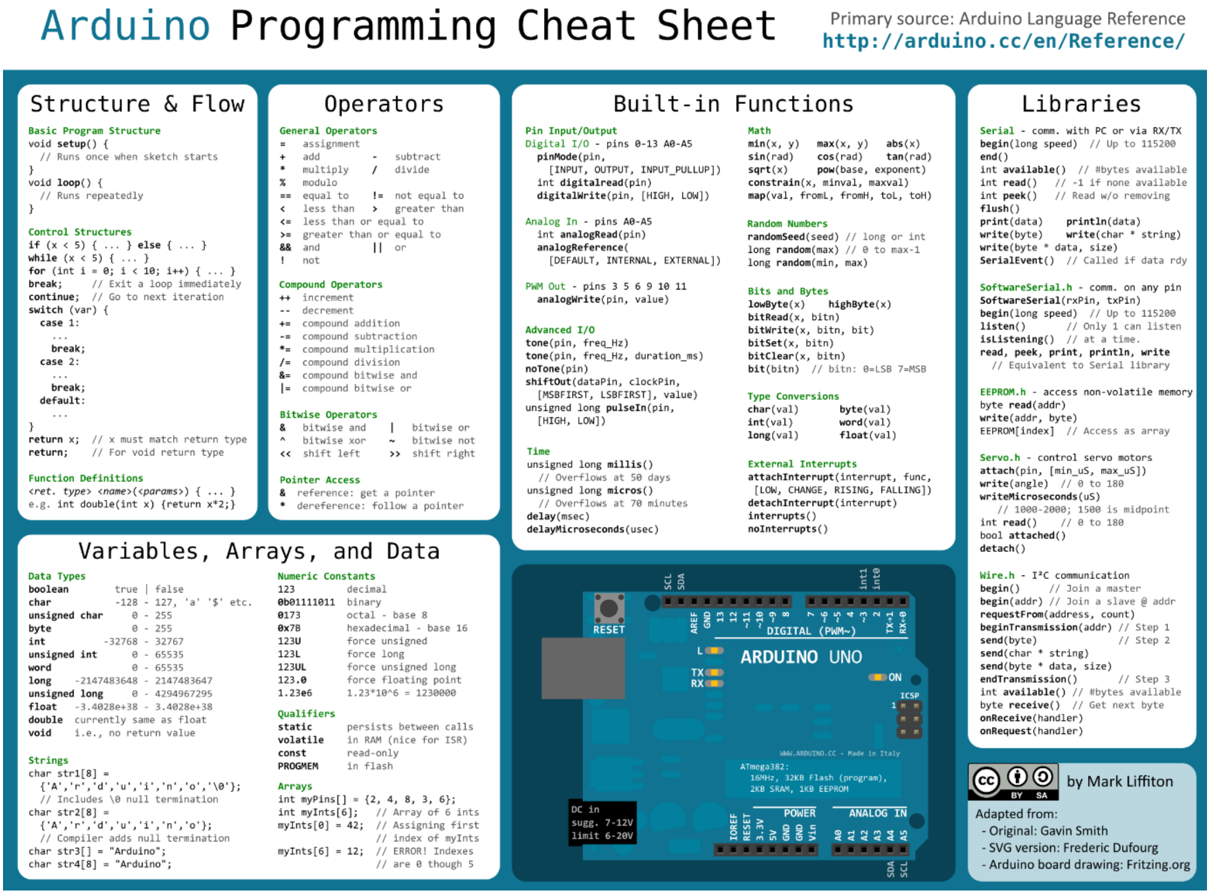
4CS016 Embedded Systems Programming Workbook 3



Arduino Programming Cheat Sheet

Primary source: Arduino Language Reference
http://arduino.cc/en/Reference/

Structure & Flow

Basic Program Structure

```
void setup() {
  // Runs once when sketch starts
}
void loop() {
  // Runs repeatedly
}
```

Control Structures

```
if (x < 5) { ... } else { ... }
while (x < 5) { ... }
for (int i = 0; i < 10; i++) { ... }
break;     // Exit a loop immediately
continue;  // Go to next iteration
switch (var) {
  case 1:
    ...
    break;
  case 2:
    ...
    break;
  default:
    ...
}
return x;  // x must match return type
return;    // For void return type
```

Function Definitions

```
<ret. type> <name>(<params>) { ... }
e.g. int double(int x) {return x*2;}
```

Operators

General Operators

```
=   assignment
+   add          -   subtract
*   multiply     /   divide
%   modulo
==  equal to     !=  not equal to
<   less than    >   greater than
<=  less than or equal to
>=  greater than or equal to
&&  and          ||  or
!   not
```

Compound Operators

```
++  increment
--  decrement
+=  compound addition
-=  compound subtraction
*=  compound multiplication
/=  compound division
&=  compound bitwise and
|=  compound bitwise or
```

Bitwise Operators

```
&   bitwise and     |   bitwise or
^   bitwise xor     ~   bitwise not
<<  shift left      >>  shift right
```

Pointer Access

```
&  reference: get a pointer
*  dereference: follow a pointer
```

Built-in Functions

Pin Input/Output

```
Digital I/O - pins 0-13 A0-A5
  pinMode(pin,
    [INPUT, OUTPUT, INPUT_PULLUP])
  int digitalread(pin)
  digitalWrite(pin, [HIGH, LOW])

Analog In - pins A0-A5
  int analogRead(pin)
  analogReference(
    [DEFAULT, INTERNAL, EXTERNAL])

PWM Out - pins 3 5 6 9 10 11
  analogWrite(pin, value)
```

Advanced I/O

```
tone(pin, freq_Hz)
tone(pin, freq_Hz, duration_ms)
noTone(pin)
shiftOut(dataPin, clockPin,
  [MSBFIRST, LSBFIRST], value)
unsigned long pulseIn(pin,
  [HIGH, LOW])
```

Time

```
unsigned long millis()
  // Overflows at 50 days
unsigned long micros()
  // Overflows at 70 minutes
delay(msec)
delayMicroseconds(usec)
```

Math

```
min(x, y)   max(x, y)   abs(x)
sin(rad)    cos(rad)    tan(rad)
sqrt(x)     pow(base, exponent)
constrain(x, minval, maxval)
map(val, fromL, fromH, toL, toH)
```

Random Numbers

```
randomSeed(seed) // long or int
long random(max) // 0 to max-1
long random(min, max)
```

Bits and Bytes

```
lowByte(x)    highByte(x)
bitRead(x, bitn)
bitWrite(x, bitn, bit)
bitSet(x, bitn)
bitClear(x, bitn)
bit(bitn)  // bitn: 0=LSB 7=MSB
```

Type Conversions

```
char(val)       byte(val)
int(val)        word(val)
long(val)       float(val)
```

External Interrupts

```
attachInterrupt(interrupt, func,
 [LOW, CHANGE, RISING, FALLING])
detachInterrupt(interrupt)
interrupts()
noInterrupts()
```

Libraries

Serial - comm. with PC or via RX/TX

```
begin(long speed)  // Up to 115200
end()
int available()  // #bytes available
int read()   // -1 if none available
int peek()   // Read w/o removing
flush()
print(data)    println(data)
write(byte)    write(char * string)
write(byte * data, size)
SerialEvent()  // Called if data rdy
```

SoftwareSerial.h - comm. on any pin

```
SoftwareSerial(rxPin, txPin)
begin(long speed)  // Up to 115200
listen()        // Only 1 can listen
isListening()  // at a time.
read, peek, print, println, write
  // Equivalent to Serial library
```

EEPROM.h - access non-volatile memory

```
byte read(addr)
write(addr, byte)
EEPROM[index]  // Access as array
```

Servo.h - control servo motors

```
attach(pin, [min_uS, max_uS])
write(angle)  // 0 to 180
writeMicroseconds(uS)
   // 1000-2000; 1500 is midpoint
int read()    // 0 to 180
bool attached()
detach()
```

Wire.h - I²C communication

```
begin()      // Join a master
begin(addr) // Join a slave @ addr
requestFrom(address, count)
beginTransmission(addr) // Step 1
send(byte)              // Step 2
send(char * string)
send(byte * data, size)
endTransmission()       // Step 3
int available() // #bytes available
byte receive()  // Get next byte
onReceive(handler)
onRequest(handler)
```

Variables, Arrays, and Data

Data Types

```
boolean        true | false
char           -128 - 127, 'a' '$' etc.
unsigned char     0 - 255
byte              0 - 255
int          -32768 - 32767
unsigned int      0 - 65535
word              0 - 65535
long   -2147483648 - 2147483647
unsigned long     0 - 4294967295
float  -3.4028e+38 - 3.4028e+38
double  currently same as float
void    i.e., no return value
```

Strings

```
char str1[8] =
  {'A','r','d','u','i','n','o','\0'};
  // Includes \0 null termination
char str2[8] =
  {'A','r','d','u','i','n','o'};
  // Compiler adds null termination
char str3[] = "Arduino";
char str4[8] = "Arduino";
```

Numeric Constants

```
123          decimal
0b01111011   binary
0173         octal - base 8
0x7B         hexadecimal - base 16
123U         force unsigned
123L         force long
123UL        force unsigned long
123.0        force floating point
1.23e6       1.23*10^6 = 1230000
```

Qualifiers

```
static       persists between calls
volatile     in RAM (nice for ISR)
const        read-only
PROGMEM      in flash
```

Arrays

```
int myPins[] = {2, 4, 8, 3, 6};
int myInts[6];   // Array of 6 ints
myInts[0] = 42;  // Assigning first
                 // index of myInts
myInts[6] = 12;  // ERROR! Indexes
                 // are 0 though 5
```

by Mark Liffiton

Adapted from:
- Original: Gavin Smith
- SVG version: Frederic Dufourg
- Arduino board drawing: Fritzing.org

http://makitpro.com/index.php/2016/04/14/arduino-cheat-sheet/

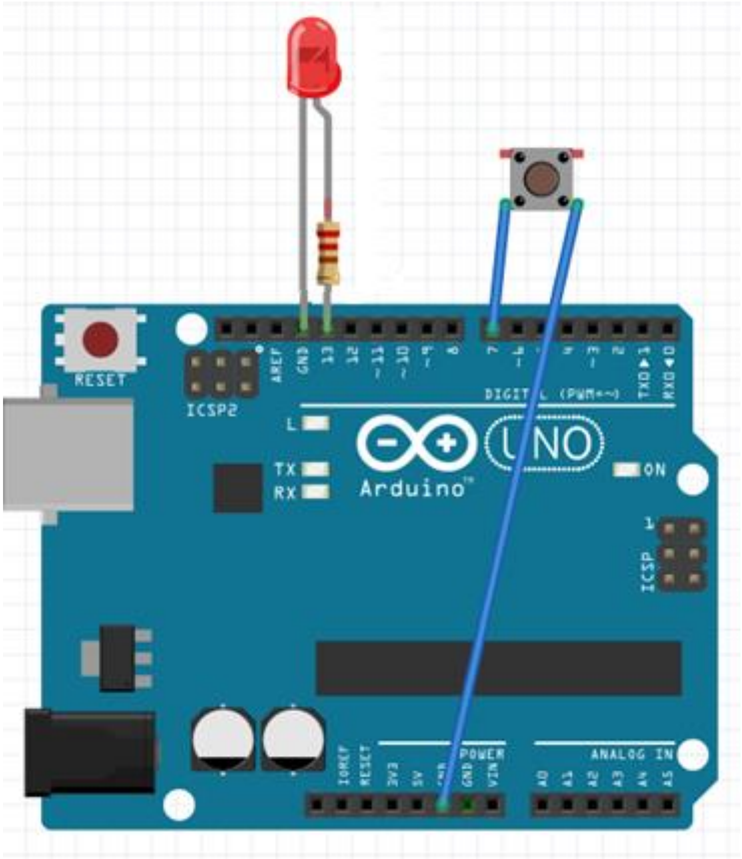
Contents

Introduction

This workbook complements the lectures for 4CS016 as such, the lecture notes will be referred to as the work progresses. You will also need to complete portfolio activities as you progress, these are highlighted as you go along.

Lab 1. Using "IF" statements for Digital Input Output

Step 1. Wire up the circuit shown in the lecture onto your breadboard.



2. Create a circuit diagram of this in Fritzing

3. Run the code from the lecture and observe the results of moving your hand near the button.

(On tinkerCAD this won't misbehave ☹)

Complete Activity 3.1 of the Portfolio

4. Adjust the circuit as shown in the lecture to resolve the floating pin.

5. Adjust the circuit and code to

- Use 3 switches and LED's
- Keep the the first led illuminated for 1 seconds when the button is pressed.
- Keep the the second led illuminated for 2 seconds when the button is pressed.
- Keep the the first led illuminated for 3 seconds when the button is pressed.

Complete Activity 3.2 of the Portfolio

End of Lab 1

Please continue with Lab 2

Lab 2. Functions

Wire 8 LED’s to the Arduino (these will represent an 8 bit binary number)

Write code so that you can pass a decimal value (0-255) to the Arduino which will light up the corresponding LED’s that will show the binary version.

```
Void displayOutput(int value) {

}
```

where “value” represents a decimal number corresponding to the binary combination

Complete Activity 3.3 of the Portfolio

End of Lab 3

End of Workbook 3